this is preferable from the viewpoint of preventing variations in the impurity concentration and of avoiding a reduction in growth rate caused by reducing the vacuum pressure.

[0188] Still further, the impurity concentration can be made uniform by forming the epitaxial film **76** over the silicon substrate **60** including the bottom and side surfaces of the trenches **61**, by forming the epitaxial film **77**, with which the trenches **61** are completely filled, and then by performing the heat treatment. In particular, by performing the steps of forming the epitaxial film **76** over the silicon substrate **60** including the bottom and side surfaces of the trenches **61**, forming the epitaxial film **77** with which the trenches **61** are completely filled, and then heat treatment in a continuous manner in the same epitaxial film forming apparatus, that is, by adopting a continuous process, cost can be cut down.

[0189] In this regard, in the film forming step and the heat treatment step, the control of a silicon source gas, a halogenide gas, and a dopant gas has been described with the drawings, but in addition to these gases, a nonoxidative or non-nitriding gas such as hydrogen or rare gas is introduced as a carrier gas into the apparatus in the atmosphere of a reduced pressure. Further, the controlling of the vacuum pressure can be also achieved by changing the amount of flow of the carrier gas as appropriate or by controlling the exhaust capacity of an exhaust pump.

[0190] Such changes and modifications are to be understood as being within the scope of the present invention as defined by the appended claims.

What is claimed is:

1. A method for manufacturing a semiconductor device comprising the steps of:

forming a trench in a semiconductor substrate; and

forming an epitaxial film on the substrate including a sidewall and a bottom of the trench so that the epitaxial film is filled in the trench, wherein

the step of forming the epitaxial film includes a final step before the trench is filled with the epitaxial film, and

the final step has a forming condition of the epitaxial film in such a manner that the epitaxial film to be formed on the sidewall of the trench has a growth rate at an opening of the trench smaller than a growth rate at a position of the trench, which is deeper than the opening of the trench.

2. The method according to claim 1, wherein

the step of forming the trench includes the steps of:

forming an oxide film on the substrate as a mask for forming the trench; and

removing the oxide film after the trench is formed and before the step of forming the epitaxial film.

3. The method according to claim 1, wherein

the semiconductor substrate is a silicon substrate,

the bottom of the trench has a (110)-surface orientation of silicon crystal, and

the sidewall of the trench has a (111)-surface orientation of the silicon crystal.

4. The method according to claim 1, wherein

the semiconductor substrate is a silicon substrate,

the bottom of the trench has a (100)-surface orientation of silicon crystal, and

the sidewall of the trench has a (100)-surface orientation of the silicon crystal.

5. The method according to claim 1, wherein

the trench has an aspect ratio equal to or larger than two.

6. A method for manufacturing a semiconductor device comprising the steps of:

forming a trench in a semiconductor substrate; and

forming an epitaxial film on the substrate including a sidewall and a bottom of the trench so that the epitaxial film is filled in the trench, wherein

the step of forming the epitaxial film includes a final step before the trench is filled with the epitaxial film, and

the final step has a forming condition of the epitaxial film in such a manner that a mixuture of a silicon source gas and a halogenide gas is used for forming the epitaxial film.

7. The method according to claim 6, wherein

the step of forming the epitaxial film is fully performed by a forming condition of the epitaxial film that the mixuture of the silicon source gas and the halogenide gas is used for forming the epitaxial film.

8. The method according to claim 6, wherein

the step of forming the epitaxial film further includes a first step and an etching step,

the first step is such that the epitaxial film is formed on the bottom and the sidewall of the trench to have a predetermined thickness, and

the etching step is such that a part of the epitaxial film at an opening of the trench is etched by the halogenide gas so that the opening of the trench is enlarged.

9. The method according to claim 6, wherein

the final step has a second forming condition of the epitaxial film in such a manner that the epitaxial film is formed under a chemical reaction control condition.

10. The method according to claim 9, wherein

the halogenide gas includes at least one of hydrogen chloride gas, chlorine gas, fluorine gas, chlorine triflouride gas, hydrogen fluoride gas and hydrogen bromide gas.

11. The method according to claim 9, wherein

the silicon source gas includes at least one of monosilane gas, disilane gas, dichlorosilane gas, trichlorosilane gas, and silicon tetrachloride gas.

12. The method according to claim 11, wherein

the silicon source gas is monosilane gas or disilane gas, and

the epitaxial film is formed at a temperature equal to or lower than 950° C.